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E70 General Vehicle Electronics Workbook

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General Vehicle Electronics

Model: E70

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Identify the components and sub-systems that make up the vehicle electrical system
- Identify the different 2nd row seat heating options available
- Properly diagnose the 2nd row seat recognition microswitches
- Perform a rear view camera adjustment

Central Locking

The central locking is the central vehicle access system. It is responsible for unlocking and locking the vehicle. The central locking controls all vehicle doors, the upper section of the two-piece tailgate and the fuel filler flap.

The central locking can be operated via the following components:

- Remote control
- Driver's door lock barrel (door lock)
- Center lock button
- Exterior tailgate button
- Identification transmitter and outer door handle electronic module TAGE for Comfort Access.

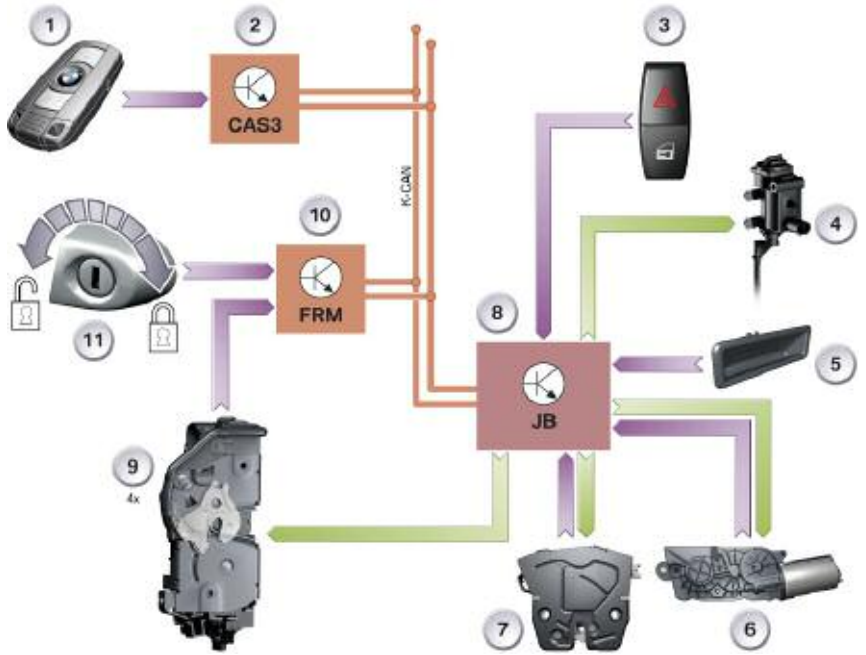
A correspondingly adapted electrical system taken from the E90 is used in the E70. For this reason, many components and functions stem from the E90.

The Car Access System now features the third generation of control units. The electronic vehicle immobilizer 4 is also used in connection with the Car Access System 3. The Car Access System 3 is backwards compatible with the Car Access System 2. Therefore, the Car Access System 3 contains all the functions of its predecessor.

It is possible to open and close the vehicle both actively or passively. Option SA 322 Comfort Access is required for the passive opening and closing function.

Note: The lower section of the tailgate is fully mechanical and can be opened as soon as the upper section has been opened.

System Overview



Index	Explanation	Index	Explanation
1	Remote control	7	Central locking, tailgate
2	Car Access System 3 CAS 3	8	Junction box control unit JB
3	Center-lock button	9	Lock (4x) in vehicle doors
4	Central locking, fuel filler flap	10	Footwell module FRM
5	Exterior tailgate button	11	Driver's door lock barrel
6	Automatic soft-close drive unit, tailgate	K-CAN	Bodyshell CAN

Wipers

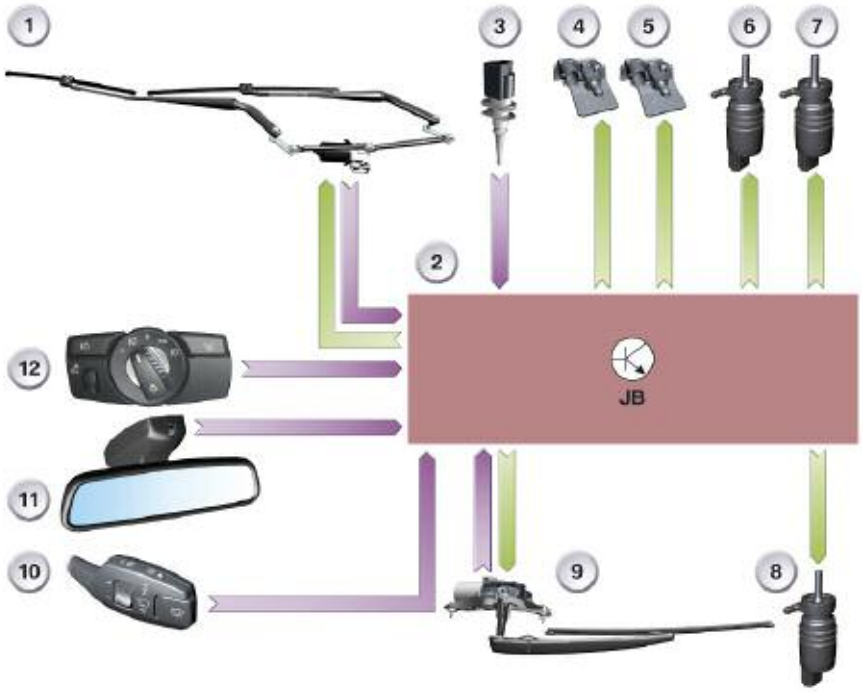
The E70 is equipped with two Windshield wipers and one rear window wiper as standard.

The wiper function is possible in the following modes:

- Intermittent wipe
- Continuous wipe in Stage 1
- Continuous wipe in Stage 2
- Flick wipe

The E70 can be optionally equipped with headlight washer system option 502. It is equipped with rain/driving lights/solar sensor and heated nozzles as standard.

The wipe/wash system on the E70 is a conventional wipe/wash system. This means that the wiper motors are equipped with a reset contact.



Index	Explanation	Index	Explanation
1	Front wiper motor	7	Motor, headlight washer
2	Junction box control unit JB	8	Motor for washer fluid pump, rear
3	Outside temperature	9	Wiper motor, rear
4	Heated water jet, driver's side	10	Steering column switch, wipers
5	Heated water jet, front passenger's side	11	Rain/driving lights/solar sensor
6	Motor, washer fluid pump, front	12	Lights operating unit

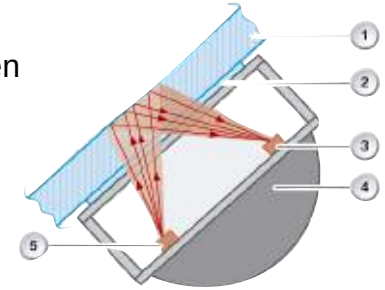
Rain Sensor

With the aid of three infrared transmit diodes and infrared receive diodes, the rain sensor evaluates the moisture level on the Windshield.

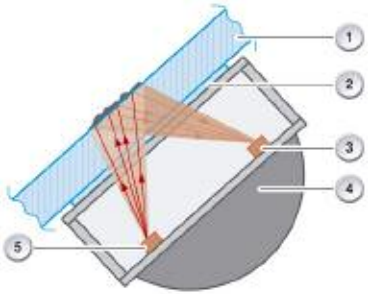
Three rain ranges are created by combining infrared transmit diodes and infrared receive diodes in pairs. The rain ranges are used to determine the rain intensity.

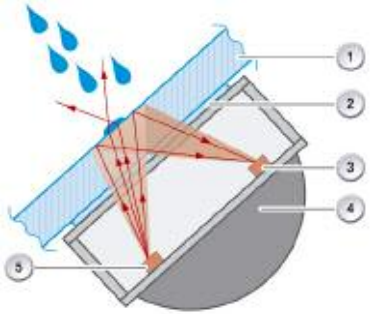
Rain detection is based on the reflection of the infrared light at the boundary surface from the glass of the Windshield to air. The reflection is dependent on the level of soiling and moisture on the Windshield.

The infrared light is reflected in full when the Windshield is clean and dry.



The reflection of the infrared light is reduced by dirt or rain water on the Windshield.





Index	Explanation	Index	Explanation
1	Windscreen	4	Rain/driving lights/solar sensor
2	Adhesive layer	5	Infrared transmit diode
3	Infrared receive diode		

The rain sensor signals the detected rain situation to the roof functions center via the LIN-bus. In turn, the roof functions center transfers the information on the K-CAN. In this way, the junction box control unit receives the request to switch the windshield wiper on or off.

The signals are:

- Sensor status
- Rain intensity
- Wiper speed
- Interval period

Driving Lights Sensor

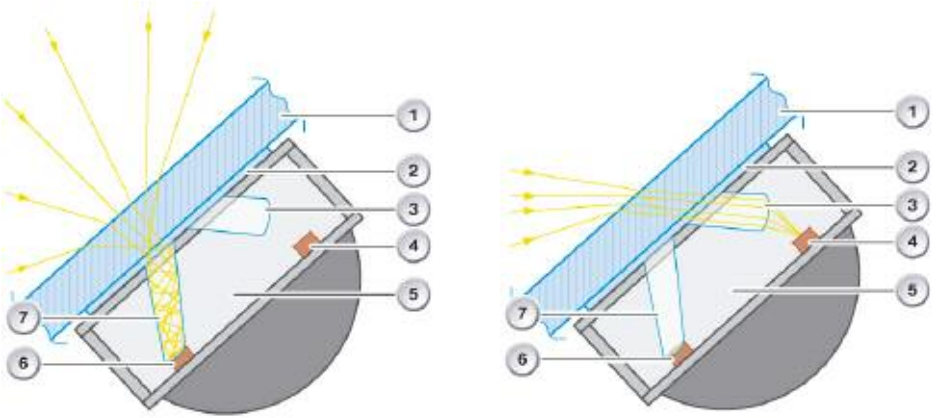
The driving lights sensor registers the ambient light and the light levels in front of the vehicle (front end). A sensor for each of these areas is integrated in the rain/driving lights/solar sensor.

The rain/driving lights/solar sensor informs the roof functions center of the driving lights situation via the LIN-bus, i.e. driving lights on/off and reason for switching on.

The roof functions center packs the signals into the corresponding K-CAN telegram and sends it. In this way, the footwell module receives the request to switch the driving lights on or off (when the automatic driving lights function is active).

The signals are:

- Status of driving lights sensor
- Ambient brightness level
- Status of driving lights
- Reason for switching on.



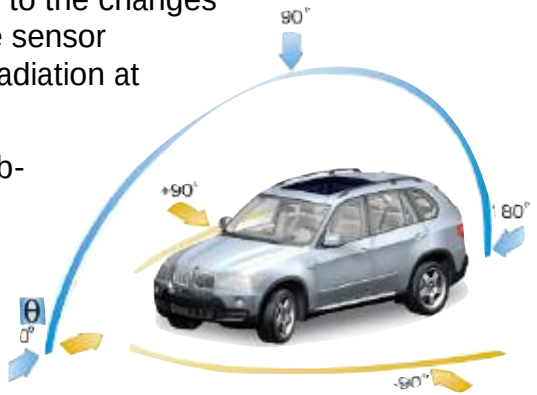
Index	Explanation	Index	Explanation
1	Windscreen	5	Rain/driving lights/solar sensor
2	Adhesive layer	6	Infrared transmit diode
3	Light optics, front end sensor	7	Receive diode, ambient light sensor
4	Receive diode, front end sensor		

Solar Sensor

The solar sensor is assigned purely to the scope of functions of the automatic heating and air conditioning system.

The solar sensor measures the angle of solar radiation (insolation) on to the vehicle. The solar radiation is measured separately on the driver's and front passenger's side.

At times the solar radiation comes from the front, from the side or sometimes from the rear due to the changes in direction while driving. The sensor therefore registers the solar radiation at all times.



Persons in the vehicle are subjected to these changing levels of solar radiation (insolation). Consequently, more heat is felt in the area of solar radiation than in the area with no solar radiation.

The solar sensor measures the solar radiation on to the vehicle depending on the position of the car with respect to the sun.

Index	Explanation
θ (Theta)	Angle of incidence of solar radiation
φ (Phi)	Course of the sun from sunrise to sunset

The values from the solar enable the integrated automatic heating and air conditioning system (climate control) to respond accordingly and create a pleasant climate in the vehicle. The roof functions center receives the values from the solar sensor via the LIN-bus and forwards the values on the K-CAN to the integrated automatic heating and air conditioning system (climate control).

RLSS Variants

Two versions of the rain/driving lights/solar sensor are used in the E70. The version depends on whether a head-up display is installed in the vehicle or not. The optics in the front end light sensor that are pervious to infrared light are replaced by clear optics for the head-up display.

The front end light sensor is directed at the area of the road which is also used for the head-up display. The brightness level of the representation in the head-up display can thus be adapted to the light situation.

This is necessary for example when driving through a tunnel with the head-up display switched on.

Installation of the rain/driving lights/solar sensor in the E70 requires the installation of the roof functions center with maximum equipment configuration. Consequently, the maximum equipment configuration of the interior lighting system is also installed.

Note: The rain/driving lights/solar sensor can best be distinguished simply by looking at the Windshield. If the rain/driving lights/solar sensor has two clear lenses then it is for the head-up display.

The optical element and the electronics of the rain/driving lights/solar sensor can be replaced separately.

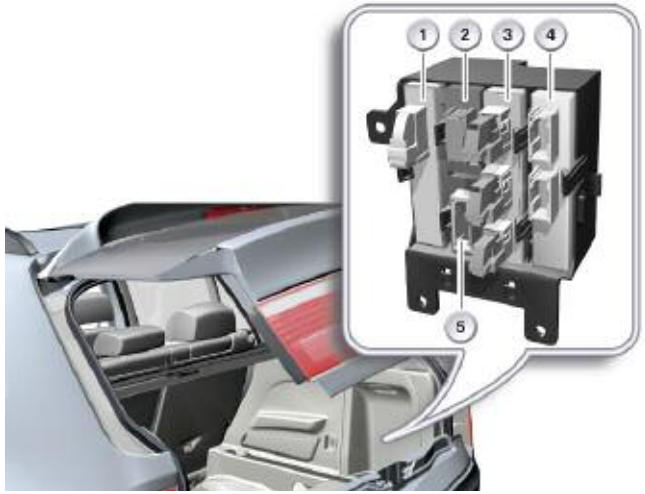
Note: An exception is the rain/driving lights/solar sensor for the head-up display. This rain/driving lights/solar sensor can be replaced only as a complete unit. The reason for this is that the optical element and the electronics need to be matched (calibrated) in the sensor for the head-up display. This is currently possible only as part of the rain/driving lights/solar sensor manufacturing process.

The occurrence of small bubbles on the silicon gel layer (adhesive layer) is OK (permitted) when replacing the optical element. Please remember to initialize the rain/driving lights/solar sensor.

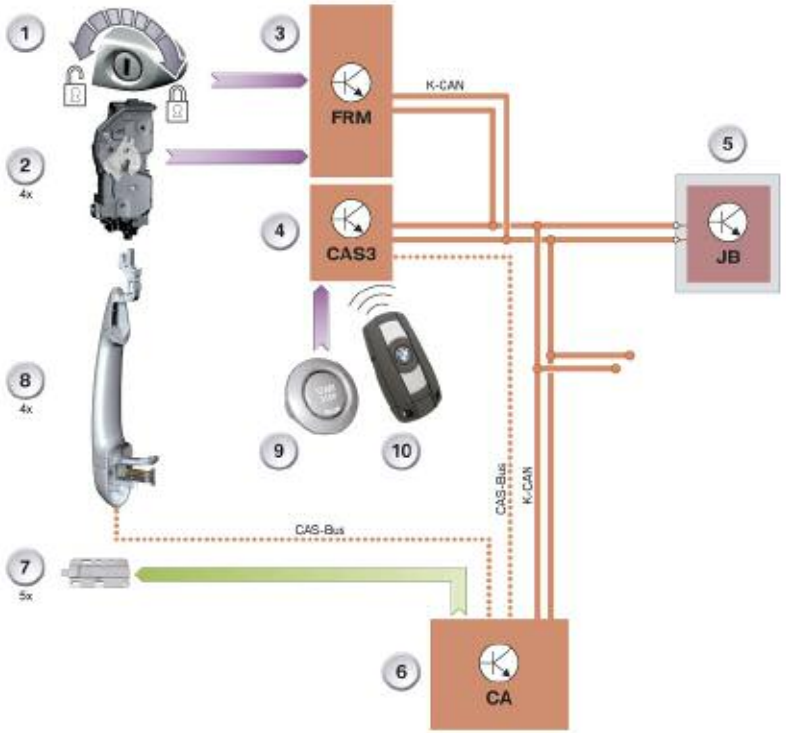
Comfort Access

Using Comfort Access the customer can unlock and open the vehicle without active use of the ID transmitter. It is unimportant how the customer wishes to access the vehicle. It is important that the ID transmitter be located in the vehicle's immediate vicinity (approximately 2m). It is sufficient to have the ID transmitter somewhere on your person.

The system is based on the Comfort Access on the E90/E91. Inserting a hand into the handle recess of the outside door handle unlocks and then opens the vehicle. The vehicle is locked by touching the sensitive area of the outside door handle.



Index	Explanation
1	Comfort Access
2	Trailer module
3	Park Distance Control
4	Vertical Dynamic Management
5	Electronic ride-height control



Index	Explanation	Index	Explanation
1	Driver's door lock cylinder	7	Interior antenna x 5
2	Lock with door contact x 4	8	Outside door handle electronics module
3	Footwell module FRM	9	START-STOP button
4	Car Access System 3 CAS 3	10	ID transmitter
5	Junction box control unit JB	K-CAN	Body CAN
6	Comfort access CA	CAS-Bus	CAS-bus (K-bus protocol)

Seats

Front Row Seating

There are two different seats available:

- Sport seat
- Multifunction seat (comfort seat) option

Second Row Seating

The E70 is a five-seater in its standard equipment specification, two seats in the front (driver and Passenger) and three seats in the row just behind the front seats. This is referred to as second row seating (back seat). It offers the opportunity of folding down the backrest completely, thereby increasing the luggage-compartment volume.The backrest are divided into two parts, the ratio being 60/40.

Front and Second Row Seating

Third Row Seating

The Passenger seating capacity can be extended to seven by ordering the third row seating option.The additional two seats are situated in the luggage compartment and can be folded down completely.

This row of seats is referred to as third row seating or 5 + 2 seat concept and are not equipped with seat heaters. However, an independent heating unit option is available just for the third row seats.

Third Row Seats

The Seat heating option is also available for second row seats. Seat heating is an option The seat heating option cannot be ordered individually. This means that it can only be ordered in conjunction with the Front Seat-heating option.

Seat heating for the second row is available in two equipment specifications:

- Without automatic rear-cabin air conditioning
- With automatic rear-cabin air conditioning

Rear Seat Heating without Automatic Rear-cabin Air Conditioning

The seat heating features two heating circuits each in the right and left seat halves. Each of the heating circuits has a heating area for the backrest and the seat cushion.

The seat heating is connected to the "Terminal 15" relay. The seat heating can therefore only be activated from "Terminal 15 ON". The seat heating can be switched on individually for the left or right seat half with buttons.

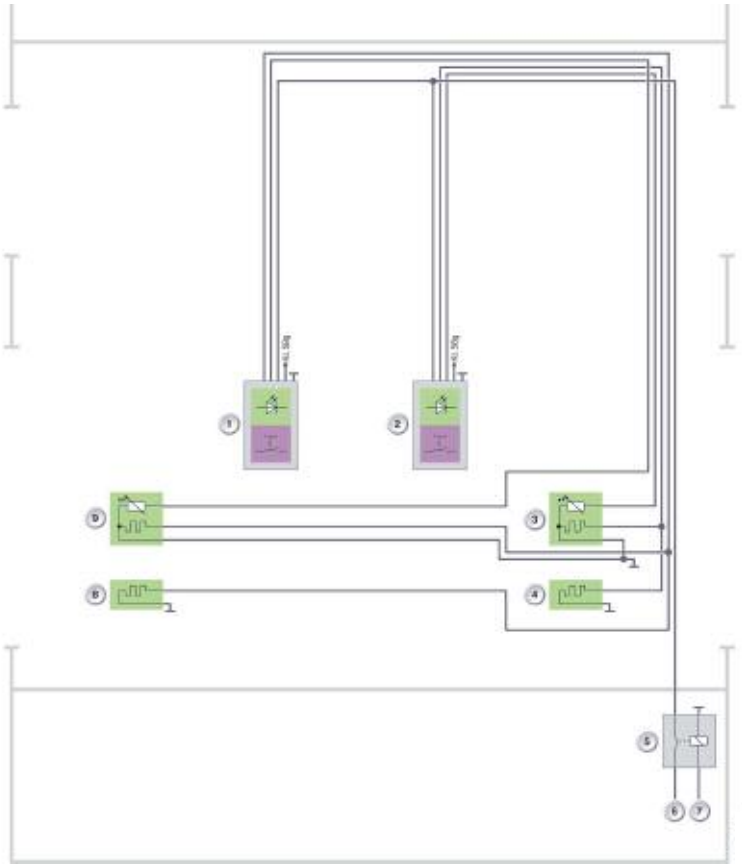
The seat-heating buttons are integrated under the air vents in the rear center console.

The seat heating can be switched on in two heating stages. The heating stages and their indications are set out in the following table.The seat heating is controlled by means of an NTC resistor in the heating mat of the seat surface. The buttons are resistance-coded and make a different supply voltage available for the seat heating.

Heating stage	Seat	Backrest	LED
2	Normal	Normal	2
1	Low	Low	1
0	OFF	OFF	OFF

Index	Explanation
1	Seat-heating button, driver's side, rear
2	Seat-heating button, front passenger side, rear

Rear Seat Heating without FKA Circuit Diagram



Index	Explanation	Index	Explanation
1	Seat-heating button, driver side, with function indicator	6	Terminal 30 (distribution box, front)
2	Seat-heating button, front passenger side, with function indicator	7	Terminal 15 ON (switched by CAS3)
3	Seat heating, seat surface, front passenger side	8	Seat heating, backrest, driver side
4	Seat heating, backrest, front passenger side	9	Seat heating, seat surface, driver side
5	Relay, terminal 15	KL 58g	Terminal 58 switched

Note: The Car Access System 3 actuates a relay in the front distribution box. The front distribution box is thus supplied with "Terminal 15 ON" (7). The Terminal 15 relay (5) among others is connected to this supply.

Rear Seat Heating with Automatic Rear-cabin Air Conditioning

The seat heating has two heating circuits, as described above. It does, however, have a seat-heating seat module.

The function of the seat heating is integrated completely in the seat-heating seat module. The seat-heating seat module is connected to terminal 30 for the load current.

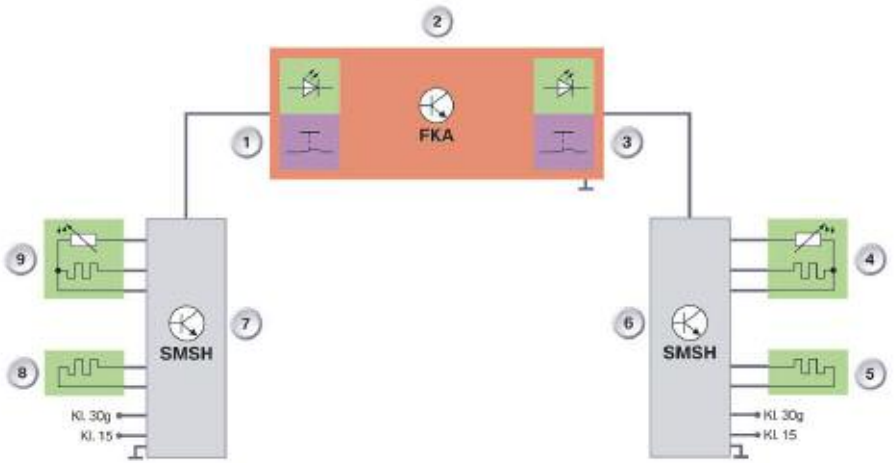
The seat heating can be activated from the status "Terminal 15 ON". Automatic rear cabin air conditioning receives the status "Terminal 15 ON" via the K-CAN.

The buttons for operating the seat heating are integrated in the control panel for automatic rear-cabin air conditioning. The automatic rear-cabin air conditioning ECU evaluates the buttons and activates the seat heating depending on the selected heating stage.

The seat-heating seat module is supplied with a pulse-width-modulated signal for this purpose. The pulse width corresponds to the required heating stage.

The seat-heating seat module executes the request and monitors the seat heating. The seat-heating seat module determines the set temperature by means of an NTC resistor in the heating mat of the seat surface.

Rear Seat Heating with FKA Circuit Diagram



Index	Explanation
1	Seat-heating button, driver side, with function indicator, rear
2	Automatic rear-cabin air conditioning
3	Seat-heating button, front passenger side, with function indicator, rear
4	Seat heating, seat surface, front passenger side
5	Seat heating, backrest, front passenger side
6	Seat-heating seat module, front passenger side, rear
7	Seat-heating seat module, driver side, rear
8	Seat heating, backrest, driver side
9	Seat heating, seat surface, driver side
KL 30g	Terminal 30 switched
KL 15	Terminal 15 (distribution box, front)

Seat Heating Buttons with FKA

Index	Explanation
1	Seat-heating button, driver side
2	Seat-heating button, front passenger side

The seat heating can be switched on in three heating stages.
The heating stages and their indications are set out in the following table.

Heating stage	Seat	Backrest	LED
3	High	High	3
2	Normal	Normal	2
1	Low	Low	1
0	OFF	OFF	OFF

Second Row Seat Locking

The locking function of the seat bench in the second seat row is monitored. For example, a locked seat bench ensures that it cannot come loose during driving and result in passenger injuries.

The second row seats are divided into a large and a small seat sections. The ratio is 60-40. Therefore, the large seat portion has four Micro-witches while the small seat portion has one Micro-switch for monitoring the lock.

The junction-box ECU issues a signal as soon as the contact to the ground connection is interrupted. The signal alerts the customer that the second row is not locked correctly.

The Large Seat Section

Micro-witches are installed for the backrest and seat surface for monitoring the large seat section. On the backrest there is only one Micro-switch, on the outside.

There are two further Micro-witches in the seat bottom, on the inside and outside of the locks. Another Micro-switch is located on the seat-cushion arm in the seat bottom to detect when the back-rest is in the fully set-down in position and locked.

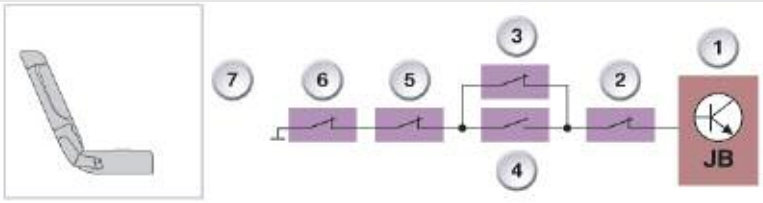
All the switches are closed when the seat section is correctly locked. One of the switches of a locked seat is always open or closed. The following seat states are monitored:

- Large seat half, backrest, folded up and locked
- Large seat half, backrest, folded down
- Large seat half, seat surface tilted
- Large seat half, seat surface locked

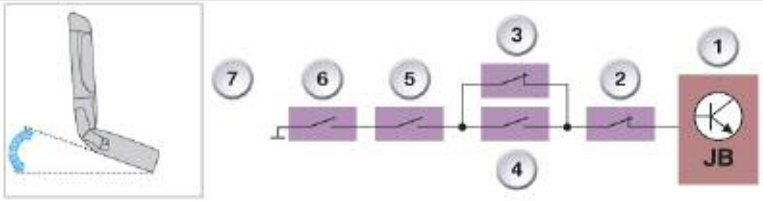
The Small Seat Section

The small seat section is monitored by a Micro-switch, since there is no belt integrated in the backrest. The Micro-switch is situated on the mechanical lock on the inside of the seat bottom. The switch is closed when this seat is correctly locked.

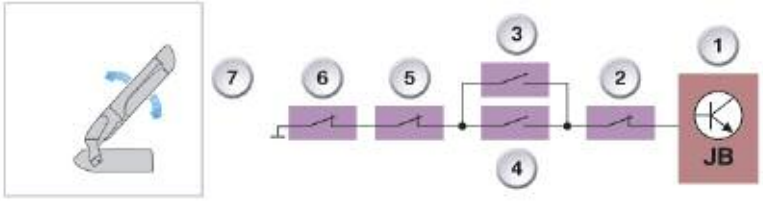
Index	Explanation
1	Micro-switch, seat (40 % seat, lock on seat bottom)
2	Micro-switch, large seat half (60% lock, seat, inner)
3	Micro-switch, large seat half (60% lock, outer)
4	Micro-switch, large seat half (60% backrest, outer)
5	Micro-switch, large seat half (60% seat-cushion arm, inner)



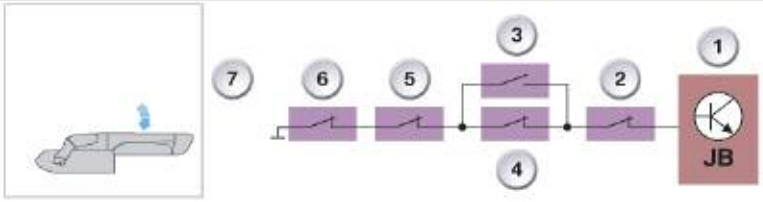
Seat position, second seat row completely locked



Large seat half, seat bench tilted (also called Easy Entry)



Large seat half, backrest, folded down, not locked



Large seat half, backrest, folded down

Index	Explanation	Index	Explanation
1	Junction-box ECU (JB)	5	Micro-switch, large seat half (backrest, outer)
2	Micro-switch, small seat half (40%)	6	Micro-switch, large seat half (seat cushion arm)
3 & 4	Micro-switches, large seat half (seat, inner/outer)	7	Seat position/backrest position

Junction-Box ECU

The junction-box ECU is the monitoring electronic control unit. In the event of an incorrectly locked seat, the junction-box ECU no longer has ground contact with this pin.

The signal level therefore changes from Low to High. The junction-box ECU issues a check control message and alerts the driver to an unlocked seat.

Third Row Seat

The seat concept described above can be extended by the 5+2 seat concept. This is available as the 5+2 seat-extension option. The additional two seats are situated in the luggage compartment and can be folded down completely. This seat row is the third row in the E70.

These seats are not equipped with seat heating. However, an independent heating option is available for the third row. More information can be found in the Product Information "E70 Heating / Air Conditioning".

Seat-position Recognition, US Version

The US version of the driver seat has seat position recognition. Seat-position recognition indicates where longitudinally the seat is situated (distance to the steering wheel). In this way, the distance between the driver and the steering wheel can be detected.

The ACSM requires this information so that it can fire the airbag under defined conditions. A more detailed description can be found in the Product Information "E70 Advanced Crash Safety Management".

Seat-position recognition is calibrated at the factory. The positions in the front and rear longitudinal seat direction are known to the seat module. A maximum distance is available for longitudinal seat adjustment.

This stretches from the mechanical front stop to the mechanical rear stop. The motor for adjustment in the longitudinal direction generates Hall pulses over this distance. The seat modules uses these Hall pulses to identify the current (absolute) seat position.

An area for example in which a person of short stature would sit is defined in the longitudinal direction. The absolute seat position can be lost due to specific causes. The seat must therefore be calibrated. Please refer to the Service Information.

Workshop Exercise - Second Row Seat Locking Detection

Using an instructor assigned E70 vehicle, the Seat Position Micro-switches poster and diagnostic equipment, answer the following questions.

1) Locate and display the Second Row Seat Locking Detection system schematic.

Draw the Micro-switch schematic in the box below.

2) How many switches are used in the system?

Circle the best possible answer.

Two Four Five

3) What type of circuit are the Micro-switches wired in?

Circle the best possible answer.

Parallel Series Parallel Series

4) *Unlock and operate the seat (Easy entry function) and note what happens*

5) *Unlock the large seat backrest, pull forward and note what happens.*

6) Which air bag triggering logic is affected directly by this monitoring system?

Circle the best possible answer.

Driver and Passenger Curtain Air Bags

Side Air Bags None

Steering Column Switch Electronics

A steering column switch cluster SZL is used on the E70 that can detect the steering angle and the settings of the steering column switches for wiper, direction indicator light and cruise control by means of optical sensors.

In addition to the optical sensors, buttons based on switching-mat technology are used for the buttons on the multifunction steering wheel and various buttons on the steering column stalks. The voltage signals are read by the steering column switch cluster.

The information from the switches and steering angle sensor are in part processed in the steering column switch cluster and transferred to other systems via the F-CAN. A part of the information is forwarded directly to other control units.

Note: In terms of design and function, the steering column switch cluster essentially corresponds to the steering column switch cluster on the E90. A new feature is the electronic steering wheel module that is responsible for controlling the steering wheel heating.

Steering Wheel Heating

The steering wheel heating is controlled by the electronic steering wheel module. The electronic steering wheel module is accommodated in the steering wheel.

The steering wheel heating is activated by means of a switch on the steering wheel. The switch is connected directly to the electronic steering wheel module. The power is supplied via two dedicated connections.

To prevent overloading the electrical system, the function can be deactivated by the IHKA by means of a power-down connection.

Index	Explanation
1	Steering Wheel Heating Indicator Light
2	Steering Wheel Heating Button

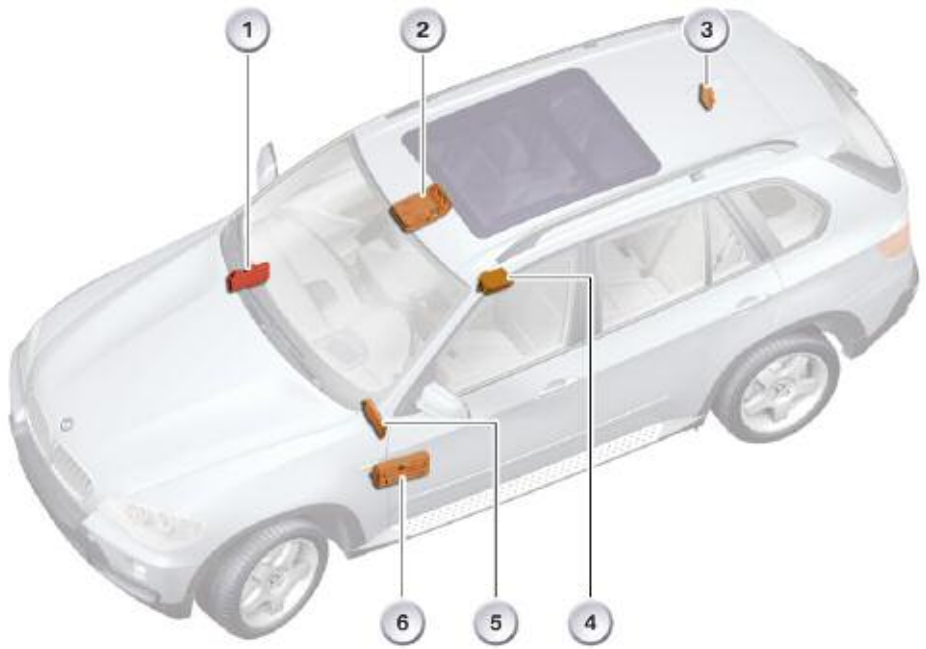
Interior Lighting

The interior lighting in the E70 is based on the interior lighting system implemented in the E90. The interior lighting comprises the roof area, luggage compartment, footwell and inner door lighting.

The lighting in outer area of the doors is provided by the courtesy lighting (outer door handles) and the exit lights. The interior lighting in the roof area on the rear driver and passenger sides consists of two separate lamps. A new feature is the split glove compartment.

The complete glove compartment lighting is powered and controlled by an electronic module in the unlocking/release drive unit.

The following diagram shows where the control units responsible for the interior lighting are located in the E70.



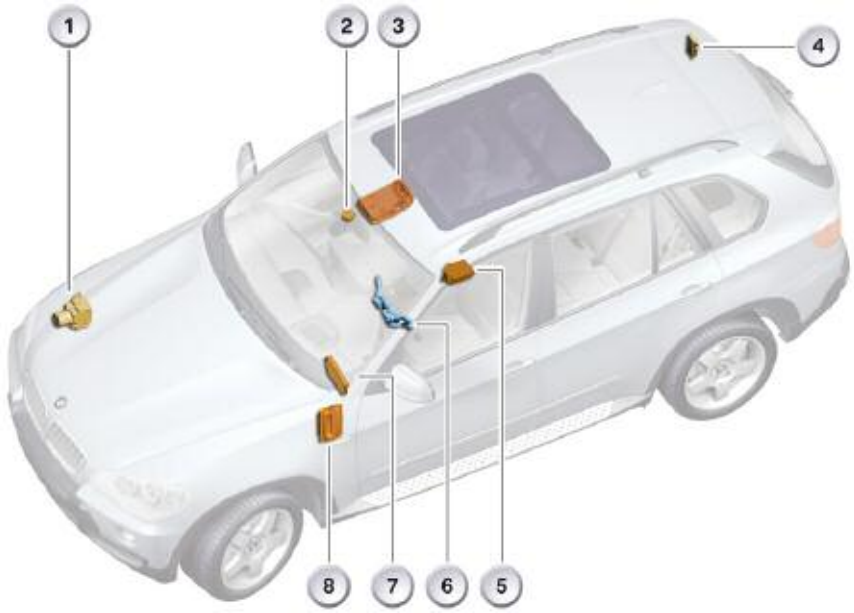
Index	Explanation
1	Junction box control unit
2	Advanced crash safety management
3	Roof function center
4	Car access system 3
5	Comfort Access
6	Footwell module

Exterior Lighting

The exterior lighting in the E70 is based on the exterior lighting system implemented in the E90. The E70 features the welcome light, making the vehicle even more customer-friendly.

The exterior lighting system is switched on for approximately 20 seconds when the vehicle is unlocked. This has the advantage of locating the vehicle more easily under unfavorable light conditions.

A further feature is the daytime driving light that can be activated or deactivated via the Personal Profile.



Index	Explanation	Index	Explanation
1	Dynamic stability control	5	Advanced crash safety management
2	Rain/driving lights/solar sensor*	6	Steering column switch cluster
3	Roof functions center	7	Car Access System 3
4	Vertical dynamics management *	8	Footwell module

Welcome Light

The light switch must not be in position "0" or "1" in order to activate the welcome light. Furthermore, the parking lights or side lights must also not be activated.The welcome light is switched on as soon as the vehicle is unlocked. For this purpose, the Car Access System 3 makes available the status of the central locking system via the K-CAN.

The footwell module receives the "Unlock vehicle" status and switches on the exterior lighting for approximately 20 seconds. The ON time can be set to up to 60 seconds via the personal profile. While switched on, the welcome light can be deactivated with the "Terminal R ON" status.

The following light units are activated:

- Tail lights
- Corona rings
- Side markers
- Interior lighting
- Courtesy lighting

Park Distance Control / Rear View Camera

Park Distance Control

The Park Distance Control (PDC) is a distance warning system that provides both visual and audible information on the distance to the nearest obstacle when parking and driving out of spaces.

The park distance control is optionally available in the E70.

The distance to the next obstacle is measured by means of four ultrasonic sensors in the rear bumper and four ultrasonic sensors in the front bumper. The distance is signalled audibly via the speakers in the rear and front area of the vehicle. The frequency of the signal increases as the distance to the obstacle decreases.

A continuous signal is output in very close proximity to obstacles (about 30 cm).

The distance signalling is shown in graphic form on the central information display CID.

The park distance control can be switched on and off by means of a button in the center console switch cluster SZM.

The following changes/new features have been implemented compared to the predecessor models:

- New converter and new control unit
- Visual representation of distance to obstacle
  - via display generated by the CCC
  - via display generated by the Rear View Camera
- Audible signalling through audio system speakers

Rear View Camera

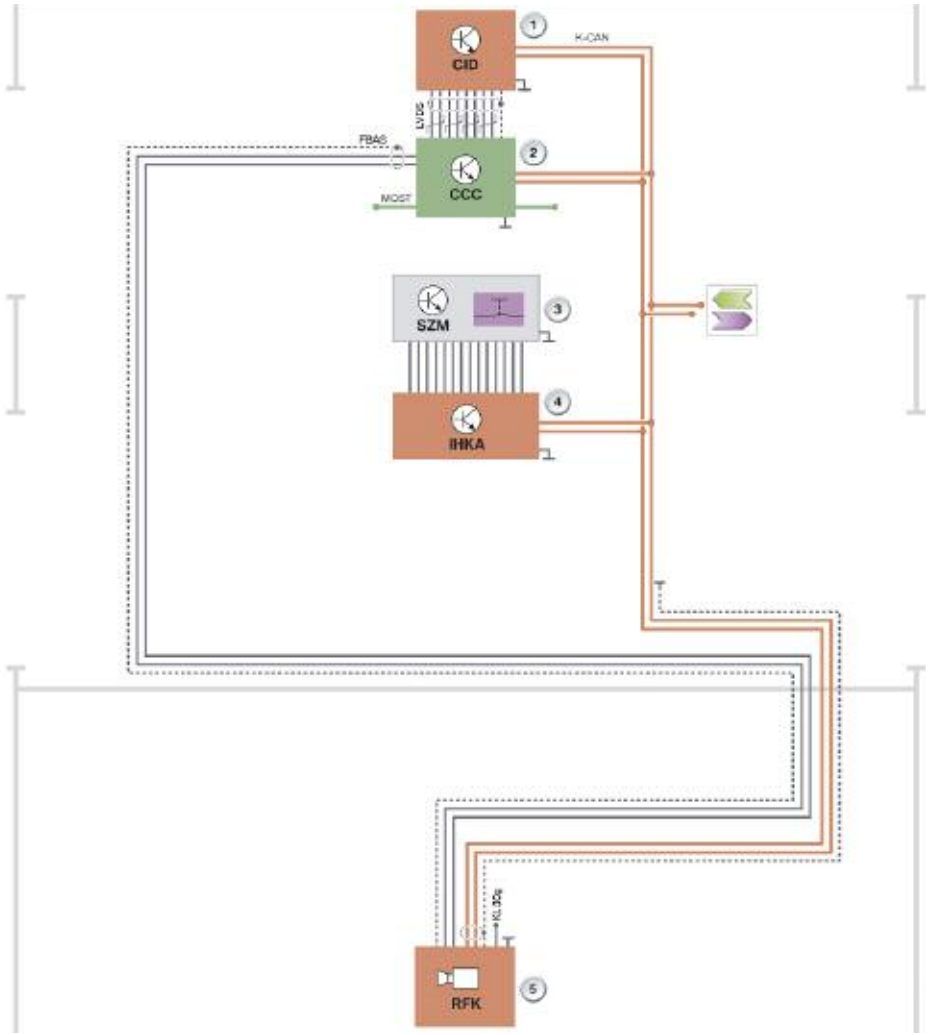
The Rear-view camera system (RFK) serves to assist the driver when driving into/out of parking spaces and maneuvering.

As well as showing a high-quality wide-angle image of the area behind the vehicle, the system contains a series of additional customer functions.

The system is located in the tailgate. The Rear-view camera is located offset to the right of vehicle center in the tailgate strip handle.

The Rear-view camera is activated automatically together with the park distance control by engaging reverse gear or manually by pressing the parking button. A wide angle color image of the area behind the vehicle is shown on the central screen. The electronic equalizer ensures natural perspectives in the image. Driver assistance graphics in the image show the calculated space requirement for parking into spaces and maneuvering referred to the current steering wheel position thus assisting the driver when parking into spaces. The shaded obstacle markings in the real camera image that are based on the ultrasonic sensor system help the driver (in addition to the PDC warning tone) to pay particular attention to obstacles and confined areas when parking into spaces and maneuvering.

Selection menus on the central information display allow for interactive changes to the system settings. Automatic activation of the system can also be disabled in these menus. Following activation after opening the vehicle, the rear-view camera is not available before the navigation display is operational.



Index	Explanation	Index	Explanation
1	Central information display	6	Video module
2	Car communication computer	K-CAN	Body CAN
3	Center console switch cluster	LVDS	LVDS data line
4	Automatic climate control	FBAS	CVBS line
5	Rear-view camera	MOST	Media Oriented System Transport

In/Out	Signal	Source	Function
In	PDC signals	PDC sensors PDC control unit	Information for super-imposing distance graphics
In	PDC button	PDC button in center console - IHKA	Activation and deacti-vation of the Rear-view camera system
In	Road speed	Wheel speed sensors - DSC control unit	Deactivation of Rear-view camera system from a speed of 20 km/h in forward driving Differentiation, forward driving/reversing
In	Configuration	Controller - Head unit (Champ/CCC)	Configuration of displays and functions of Rear-view camera system
In	Steering wheel angle	Steering angle sensor - SZL	Adaptation of lane help lines to the steer angle
In	Vehicle inclina-tion	Ride-height sensor - Footwell module/VDM	Adaptation of lane help lines to vehicle inclina-tion
In	Outside temper-ature	Outside temp. sensor - Instrument Cluster	Defrosting of rear-view camera lens
In	Distance travelled	Wheel-speed sensors - DSC control unit	Rear-view camera system switches off display after a distance of 50 m in forward direction
In	Tailgate	Contact, tailgate - CAS control unit	No lane help lines are superimposed when the tailgate is open
Out	CC messages	Head unit (Champ/CCC) > CID control unit	CC messages are for-warded to the existing head unit

Basic Functions of the Rear-view Camera System

The basic function of the rear-view camera system is to record optically a wide-angle view (about 120°) of the area behind the vehicle. The image is recorded via the lens in the rear-view camera system and then transmitted in electronically conditioned form to the car communication computer (CCC).

The video picture is transmitted via a video interface (CVBS, RGB). Communication for controlling the system in the entire vehicle and connection to the overall-bus system are effected via a K-CAN interface.

In addition, the rear-view camera system serves to show further assorted assistance information in the form of superimposed overlays (graphics and text) in the output signal (superimposed with the real camera picture).

Image Reproduction Functions

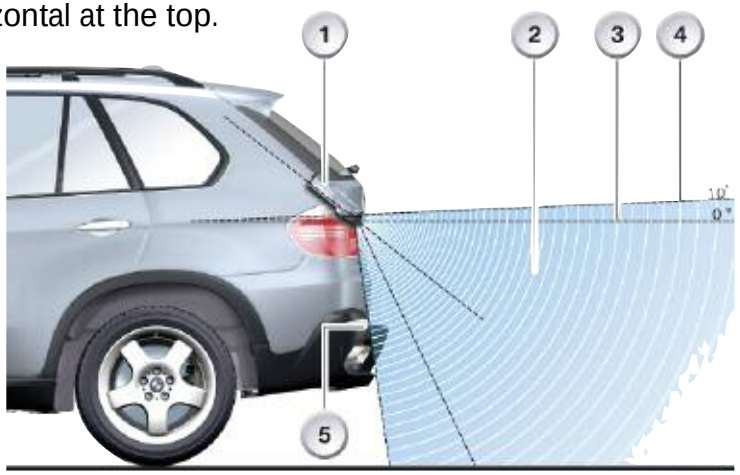
The rear-view camera system shows the view of the area behind the vehicle with a horizontal aperture angle of 120° on the central information display. The view can be shown on the navigation display in two modes:

Full image view 620x240 pixels

Main window view 400x240 pixels

Lens Coverage Alignment

The entire coverage area of the rear-view camera system ranges from the bumper at the bottom up to an angle of 10° from the horizontal at the top.



Index	Explanation	Index	Explanation
1	Rear-view camera system	4	Maximum possible upward coverage range (10° upward from the horizontal)
2	Coverage range	5	Rear bumper
3	Horizontal		

Electronic Image Equalization

The rear-view camera features an electronic image equalizer that corrects the distortions in vertical and horizontal correction caused by the principle of the wide-angle lens. The equalization algorithm must be such that the secondary effects such as information loss in the form of blurred edges as well as distortion that occurs as part of the equalization process are minimized.

The aim is to achieve the most realistic representation of the view of the area behind the vehicle that can be unmistakably interpreted by the driver.

View of Image Section

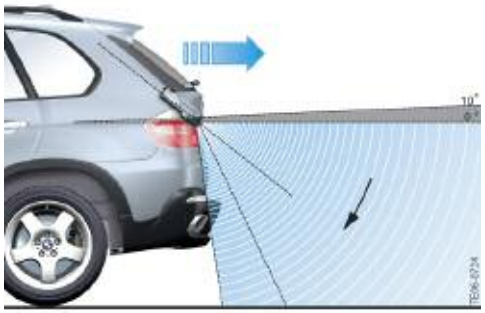
The Rear-view camera system always provides a view of a certain section of the overall image. This makes it possible to adapt to the external conditions of the vehicle. If the vehicle is parked on uneven ground so that it is not straight, the Rear-view camera system can adapt the video image corresponding to the incoming information.

This function is required for realizing the functions described in the following:

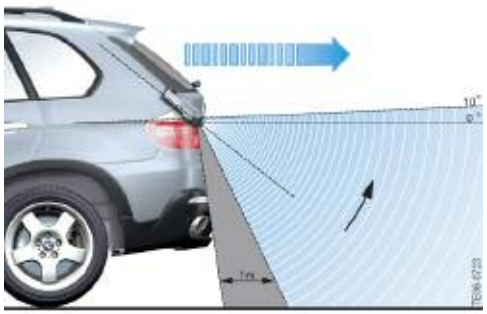
- Virtual camera pan
- Image adaptation to vehicle inclination
- Software-based system calibration

Virtual Camera Pan

Different areas are shown on the screen in vertical direction depending on the driving speed.



The bottom area of the image (from the bumper up to the horizontal) is shown when rear-view at slow speed (up to about 3 mph).



Increasingly only the upper area of the image (from about 1m distance from the vehicle up to a minimum angle of 10° above the horizontal) is shown on the screen when rear-view at faster speed (more than 3 mph).

Camera Pan as a Function of Speed

The camera pans virtually without the camera moving mechanically. This function gives the driver a view of the area behind the vehicle adapted to the current speed. When driving at slow speed, the area very close to the rear of the vehicle is shown so that every detail can be recognized. At speeds above 3 mph, the upper section of the image is shown to provide an extended view.

Additional Functions of the Rear-view Camera System

Assistance Graphics in Camera Image

Assistance graphics are superimposed on the camera image to help the driver to park into spaces and maneuver.

The following assistance graphics can be superimposed:

- Lane help lines
- Turning circle lines
- Obstacle markings
- Zoom of towing hitch

Note: The brightness can be adjusted or the image completely switched off

Lane Help Lines

The lane help lines are used to show the predicted path of the vehicle and therefore the required maneuvering space depending on the current position of the steering wheel. The lane help lines are deactivated automatically when driving in forward direction.

Turning Circle Lines

The turning circle lines mark the minimum possible vehicle turning circle. These marks remain superimposed on the image also when driving in forward direction.

Only the relevant turning circle line is shown as soon as the driver turns the steering wheel. The opposite turning circle line is blanked out depending on the steering lock and is no longer shown at full lock.

Obstacle Markings

Obstacle markings shown in the real camera image are partly transparent overlays true to scale of the obstacle detected by the PDC. The obstacle distribution in the area behind the vehicle is shown as a 3D graphic. Its form, position and color depend on the distance to each of the four PDC sensors in the bumper. Through corresponding visualization with form and color, the way the obstacle markings are represented gives the driver a spatial perspective of the obstacle distribution about the area behind the vehicle. The view corresponds to the virtual PDC view.

Personal Profile

The settings last made by each user are stored in the Rear-view camera system and retrieved after corresponding identification. The following setting options can be stored in the rear-view camera depending on the vehicle key.

- Display format (full image, main window as well as permanently switch on/off camera image)
- Lane help lines (ON/OFF)
- Turning circle lines (ON/OFF)
- Obstacle markings (ON/OFF)
- Camera pan (ON/OFF)
- Image brightness (brightness value)

System Activation

System activation by driver The Rear-view camera system can be activated by the driver by pressing the parking aid button (PDC button) as from terminal 15. The system can no longer be activated at a speed higher than 12 mph

Automatic System Activation

Initially, the Rear-view camera system is ready to send data after engaging reverse gear (identification by CAN messages) and then sends an enquiry to the CCC. In response, the CCC gives the authorization to output the video signal. The rear-view camera video signal is output only after receiving this authorization.

A corresponding error message is sent in the form of a CC message in the event of the Rear-view camera system not being available.

System Deactivation

Automatic or Indirect System Activation.

The rear-view camera is deactivated automatically in response to the following conditions:

- After exceeding a certain preset speed Vmax - forward (about 12mph) as well as
- A preset distance (about 50m) when driving in forward direction.

Deactivation by Vehicle User

Deactivation by vehicle user (while image from the rear-view camera is shown on the CID) by:

- Operating iDrive (pop-up menu)
- Pressing the PDC button

The rear-view camera is activated again when reverse gear is engaged.

Permanent System Deactivation

The rear-view camera can be permanently deactivated in the settings menu.

Rear-View Camera Design

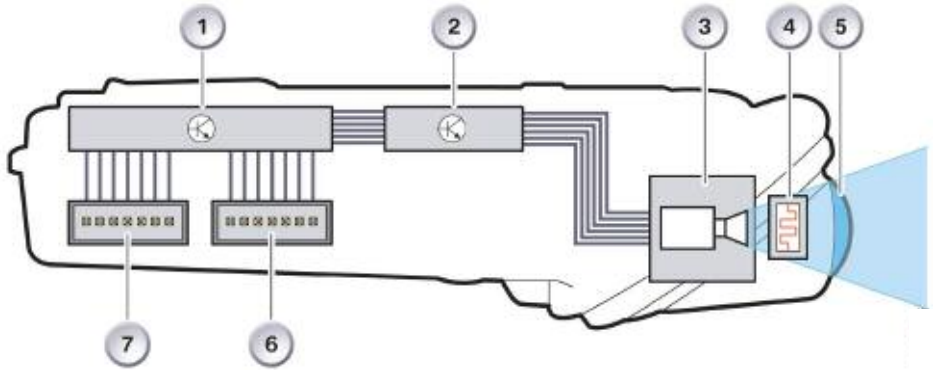
The rear-view camera is based on a CMOS sensor (Complementary Metal Oxide Semiconductor sensor) adapted for use in the vehicle with an integrated image processing unit for full-digital processing of the raw sensor data (up to 110 Mbits/s). The electronic circuitry is designed as a two-processor system. The image processing takes place in the electronic module. The following processing steps are executed:

- Histogram control - brightness and color adaptation to various exposure scenarios
- Image equalization - compensation of lens effects
- Superimposition of driver assistance line and camera pan
- Calibration functions

The tasks of bus communication, flash and boot routines and other standard applications are implemented in a separate microprocessor.

The lens with the 2.0 shutter is made up of 6 glass lenses.

It contains an automatically controlled heating element to de-ice the lens in winter. The heating element is largely controlled infinitely variable with a PWM control.



Index	Explanation
1	Processor for bus communication, flash and boot routines
2	Processor for all image conditioning functions
3	CMOS image sensor
4	Heater
5	Lens
6	Power supply and bus link connector
7	Signal output connector

Location of Rear-view Camera

The Rear-view camera system is installed on the right in the tailgate next to the tailgate lock. Tailgate seal A rubber seal seals off the housing of the rear-view camera from the tailgate.

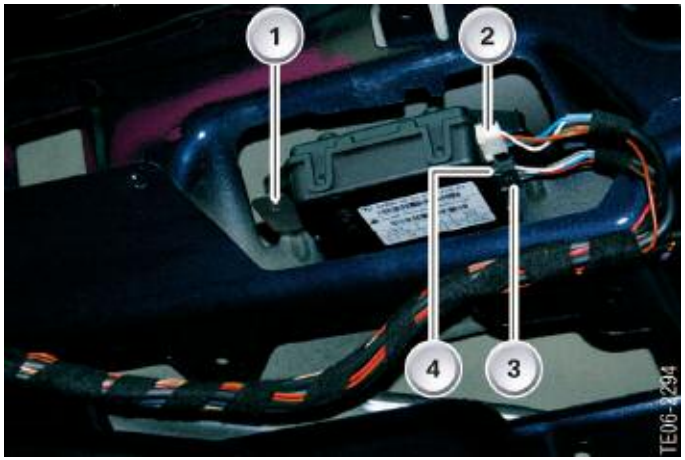
Index	Explanation
1	Tailgate handle
2	Rear-view camera seal
3	Rear-view camera lens

Mounting in the Tailgate

The rear-view camera is installed from the rear of the tailgate and secured to the housing by means of two screws.

Temperature-controlled Lens Thawing

In freezing conditions, the camera lens is heated and thawed automatically to keep it free of snow and ice.



Index	Explanation
1	Mounting screw
2	Connector, white (power supply and bus connection)
3	Mounting screw
4	Connector, black (video signal)

Calibration of the Rear-view Camera

In order to maintain the accuracy of the rear-view camera, a calibration procedure must followed as per the latest BMW Service information found in TIS or on the GT-1.

Workshop Exercise - Rear View Camera Adjustment

Using an instructor assigned E70 vehicle, adjust the rear view camera through the test plan outlined in the diagnostic equipment.

1) What is the special tool part number used for the rear view camera adjustment?

2) Write the path used to locate the service function for adjusting the rear view camera.

3) When is the rear view camera adjustment required?

4) When is the rear view camera adjustment required?

Anti-Theft Alarm System

The anti-theft alarm system (DWA) is available as standard equipment. The task of the anti-theft alarm system is to indicate unauthorized access to the vehicle by emitting an alarm. The alarm can be triggered both audibly and visually. To do this, however, the alarm system must be armed. When activated, the alarm monitors the entire vehicle interior.

In addition, the alarm system monitors the engine compartment and the vehicle's rest position. In order that nothing can be stolen from the luggage compartment, the alarm system monitors the tailgate.

The alarm also indicates if the vehicle has been tampered with like cutting the feed line to the emergency siren.

The anti-theft alarm system is based on the E90. However, the alarm system's ultrasonic passenger-compartment sensor is located fully in the roof function center.

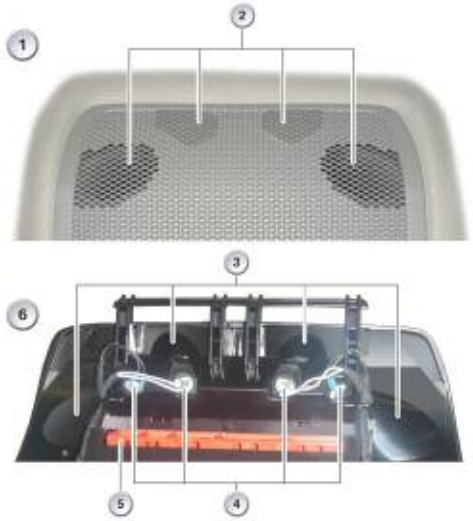
The ultrasonic signal passes into the inside of vehicle through openings in the grill of the roof function center. The emergency power siren with tilt alarm sensor is located near the front wheel arch.

Ultrasonic Passenger Compartment Protection

The ultrasonic passenger-compartment sensor captures and evaluates movements in the vehicle interior. Initialization of the ultrasonic passenger-compartment sensor is started 3 s after closing the engine bonnet, tailgate and the last door.

The ultrasonic passenger-compartment sensor is operational 20 s after the start of initialization and is included in the vehicle monitoring system. The ultrasonic passenger compartment sensor has been integrated into the roof function center. The roof function center is connected to the K-CAN and DWA bus.

Ultrasonic Passenger Compartment Protection



Index	Explanation	Index	Explanation
1	Front of roof function center	4	Ultrasonic sensor
2	Exit openings of ultrasonic sensors	5	Roof function center connector
3	Funnel for ultrasonic sensors	6	Rear of roof function center